Available online on 15.04.2025 at http://jddtonline.info

Journal of Drug Delivery and Therapeutics

Open Access to Pharmaceutical and Medical Research

Open Access Full Text Article

Research Article

Formulation and Evaluation of Arjuna Bark Chocolate for Heart Disease Condition

Sohel Shaukat Shaikh [1]*, Vishal S. Madankar [2], Sandip Ranjeet Bhogal [3], Anil B. Panchal [4]

[1] Research Scholar, Department of Pharmaceutics, Dr. Babasaheb Ambedkar Technological University, Pune, Maharashtra, India-412216.

[2] Assistant Professor, Department of Quality Assurance Techniques, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India-412216.

[3] Research Scholar, Department of Pharmaceutics, Dr. Babasaheb Ambedkar Technological University, Pune, Maharashtra, India-412216.

[4] Assistant Professor, Department of Pharmaceutics, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India-412216.

Article Info:

Article History:

Received 18 Jan 2025
Reviewed 05 March 2025
Accepted 30 March 2025
Published 15 April 2025

Cite this article as:

Shaikh SS, Madankar VS, Bhogal SR, Panchal AB, Formulation and Evaluation of Arjuna Bark Chocolate for Heart Disease Condition, Journal of Drug Delivery and Therapeutics. 2025; 15(4):52-58 *DOI: http://dx.doi.org/10.22270/jddt.v15i4.7084*

*Address for Correspondence:

Mr. Sohel Shaukat Shaikh, Research Scholar, Department of Pharmaceutics, Dr. Babasaheb Ambedkar Technological University, Pune, Maharashtra, India-412216.

Abstract

The research focuses on the formulation and development of Arjuna bark chocolate, a functional food product utilizing the therapeutic properties of Arjuna bark (*Terminalia arjuna*). Arjuna bark is renowned for its cardiovascular benefits, including its ability to improve heart health, reduce cholesterol, and enhance overall blood circulation. The study explores various formulations combining Arjuna bark extract with cocoa, sweeteners, and other functional ingredients to create a palatable and health-beneficial chocolate product. Through sensory evaluations, stability tests, and antioxidant analysis, the formulations are assessed for taste, texture, shelf-life, and health benefits. The aim is to develop a chocolate that not only satisfies the taste buds but also provides potential therapeutic effects, particularly for individuals looking to enhance heart health naturally. The findings suggest that Arjuna bark chocolate could serve as an innovative health snack, offering both enjoyment and functional benefits.

Keywords: Herbal Chocolate, Arjuna Bark Extract, Heart Disease, Cocoa Butter.

INTRODUCTION

Now-a-days the peoples are very health conscious and prefer to buy foods that offer both nutrition and wellbeing. Owing to the growing consumer demands, a wide-array of functional foods, which offer nutrition and specific health benefits, were developed. This research aims to create and assess nutrition chocolate with a natural cardiac tonic, focusing on the health benefits of cocoa. Chocolate-related products have been used as medicine for centuries due to their flavonoids, which function as antioxidants, lower blood pressure, and balance hormones. Dark chocolate has a higher concentration of antioxidants than milk or white chocolate. Chocolates have positive effects on mood, stress management, cognitive function, cardiovascular disease, and energy levels. The study focuses on the formulation and evaluation of a wholesome chocolate containing powdered arjuna bark, a native tree of Bangladesh. The bark contains glycosides, flavonoids, tannins, and minerals, which support heart health and mitigate stress and anxiety. *Terminalia arjuna* bark is known for its anti-inflammatory, antioxidant, and lipid-lowering qualities, as well as its cardiotonic qualities[1-3].

DRUG PROFILE:

Terminalia Arjuna

Terminalia Arjuna is an ayurvedic plant with important medicinal value. It is commonly known as Arjuna, Indradru, Partha and Veeravriksha[4] which is belongs to Combretaceae family comprising of nearly 200 species distributed around the world. Nearly 24 species of Terminalia have been reported from various parts of India, some selected species are *Terminalia arjuna, Terminalia bellirica, Terminalia bialata, Terminalia catappa, Terminalia elliptica, Terminalia porphyrocarpa, Terminalia mantaly* etc. In India, T. arjuna is about 60–80 feet in height, buttressed trunk and horizontally spreading crown and drooping branches distributed in India, Burma, Mauritius and Sri Lanka[5]. T. arjuna is distributed throughout sub Indo-Himalayan tracts of

Uttar Pradesh, Punjab, Deccan, South Bihar, Orissa, West Bengal and Madhya Pradesh mainly along riverside, rivulets and ponds. It is known by its various vernacular names, the most commonly used ones are Arjuna (Common Name), Arjun (Hindi), Marudhu (Tamil and Malayalam), Tella Maddi (Telugu), Arjhan (Bengali), Sadaru (Marathi), Sadado (Gujarati), Neer matti (Kannada) and some traditional formulations prescribe in the name of Arjunarishta and Arjunaghrita[6-7].

Figure 1: *Terminalia arjuna*

The bark of this tree is the main medicinal component used for therapeutic purposes. Along with Arjuna powder benefits in numerous skin issue, it is also known for its cardioprotective actions. The medicinal properties of *Terminalia Arjuna* range from antioxidant, hypotensive, anti-atherogenic, anti-inflammatory, anti-carcinogenic, and anti-mutagenic to gastro-productive effects.

Figure 2: Arjuna Bark

MEDICINAL USES:

1) Myocardial Infarction:

The anti-ischemic effect of bark powder was evaluated in 30 patients of stable angina/post-infarct angina (500 mg tds). The authors observed that the mean anginal frequency decreased significantly, along with a significant decrease in systolic blood pressure (SBP), improvement in ECG changes, and reduction in plasma cortisol and serum cholesterol levels[8].

Later, in a study, 500 mg of bark powder was administered twice daily to 25 coronary artery disease (CAD) patients for 3 months. A reduction in the grade of positivity of treadmill test (TMT) response was observed in six patients, in addition to improvement in exercise tolerance and a reduction in the frequency of anginal attacks and use of sublingual nitrates[9].

2) Hypertension:

In one of the earliest studies, 10 patients with CHF received 4 g of arjuna bark powder twice daily for 1 month. The researchers observed improvement in the functional class, breathlessness, and overall well-being with significant diuresis, and a fall in both systolic and diastolic blood pressure[10].

Subsequently, the effect of bark extract (500 mg 8 hourly) was studied in a double-blind placebo-controlled two-phase trial comprising 12 patients with refractory CHF. In the first phase, arjuna was administered for a period of 2 weeks. A decrease in echo-left ventricular end-diastolic and end-systolic volume indices, an increase in left ventricular stroke volume index, and an increase in LVEF were recorded suggesting improvement. On long-term evaluation (20-28 months), in addition to continued improvement in symptoms and signs, they also reported an improvement in quality of life[11].

Study done with abana (herbal formulation containing arjuna) in hypertensive individuals revealed an improvement in cardiac function as indicated by an increase in ejection fraction and a significant reduction of the SBP, echocardiographic left ventricular internal diameter, posterior wall thickness, and interventricular septal thickness[12].

Recently, arjuna has also been shown useful in improving cardiovascular endurance and in lowering SBP in normal healthy subjects[13].

3) Cardiomyopathy:

In addition to its anti-ischemic property, arjuna was found to reduce LVM and improve LVEF. A recent observational study revealed that when patients of dilated cardiomyopathy with reduced LVEF received arjuna in addition to their standard therapy, there was a significant improvement in left ventricular parameters as well as functional capacity[14].

4) Anticancer properties:

Gallic acid, ethyl galate, and flavone luteolin are found in arjuna bark. Luteolin has a proven track record of suppressing different cancer cell lines. Hydrolyzable tannin casuarinin, which was extracted from *T. arjuna* bark, inhibits the growth of human non-small cell cancer A549 cells by preventing them from progressing through the G0/G1 phase of the cell cycle and by triggering apoptosis. *T. arjuna* water extract contributes to its anti-carcinogenic properties by inhibiting anaerobic metabolism and lowering oxidative stress.

5) Antioxidant Properties:

The antioxidant activity of Arjuna bark plays a critical role in protecting the heart and blood vessels from oxidative damage. Arjuna is rich in polyphenols and flavonoids, which neutralize free radicals that can damage heart tissue[15].

MATERIAL AND METHODS:

Table of Ingredients:

Table 1: Ingredients

S. N.	Ingredients	Role
1	Cocoa butter	Provides smooth texture
2	Cocoa powder	Flavour enhancer
3	Arjuna bark powder	Active Ingredient
4	Honey	Emulsifier
5	Vanilla	Flavoring Agent
6	Milk powder	Creamy texture and taste
7	Sugar	Sweetener

METHODOLOGY:

Trail 1:

Formulation Table:

Table 2: Formulation Table

Sr. No	Ingredients	Quantity (50 gm)
1	Cocoa butter	20 gm
2	Cocoa powder	12 gm
3	Arjuna bark powder	5 gm
4	Honey	0.5 gm
5	Vanilla	0.5 gm
6	Milk powder	3 gm
7	Sugar	9 gm

Method of preparation:

1) Preparation of Arjuna Bark Extract:

Method: Ultrasonic Assisted Extraction (UAE):

1. Add 10 grams of Arjuna bark powder to a clean glass beaker or flask.
2. Add 50 mL of solvent (e.g., 70% ethanol) to the beaker containing the powdered bark. The solvent should completely cover the powder.
3. Place the beaker containing the Arjuna bark powder and solvent into the ultrasonic bath. Set the ultrasonic bath at a frequency of 20-40 kHz. The temperature should be maintained at 30-50°C for optimal extraction
4. Sonicate the mixture for 30 to 60 minutes. The exact time can vary based on the desired extraction efficiency, but typically, 30 minutes is enough for significant extraction.

2) Melting Cocoa Butter:

1. Add cocoa butter (20 gm) into the beaker, Stir gently until cocoa butter melts.

3) Adding Other Ingredients:

1. Affter melting cocoa butter in different beaker, melted butter was added to weighed cocoa powder and sugar
2. Honey was added.
3. Then arjuna bark extract was finally measured and added.
4. After that vanilla was added as flaouring agent.

4) Moulding and Cooling:

1. Then mixture is put into mould.
2. After that, the mould containing chocolate allowed to store in the freezer.

Observation:

First trail is failed due to Impurity occurs in extraction of drug.

Figure 3: Drug extract

Trail 2:

Formulation Table:

Table 3: Formulation Table

Sr. No	Ingredients	Quantity (50 gm)
1	Cocoa butter	10 gm
2	Cocoa powder	20 gm
3	Arjuna bark powder	5 gm
4	Honey	0.5 gm
5	Vanilla	0.5 gm
6	Milk powder	3 gm
7	Sugar	11 gm

Method of preparation:

1) Preparation of Arjuna Bark Extract:

Method: Ultrasonic Assisted Extraction (UAE):

1. Add 10 grams of Arjuna bark powder to a clean glass beaker or flask.
2. Add 50 mL of solvent (e.g., 70% ethanol) to the beaker containing the powdered bark. The solvent should completely cover the powder.
3. Place the beaker containing the Arjuna bark powder and solvent into the ultrasonic bath. Set the ultrasonic bath at a frequency of 20-40 kHz. The temperature should be maintained at 30-50°C for optimal extraction.

4. Sonicate the mixture for 30 to 60 minutes. The exact time can vary based on the desired extraction efficiency, but typically, 30 minutes is enough for significant extraction.

2) Melting Cocoa Butter:

1. Add cocoa butter (20 gm) into the beaker, Stir gently until cocoa butter melts.

3) Adding Other Ingredients:

1. After melting cocoa butter in different beaker, melted butter was added to weighed cocoa powder and sugar
2. Honey was added.
3. Then arjuna bark extract was finally measured and added.
4. After that vanilla was added as flaouring agent.

4) Moulding and Cooling:

1. Then mixture is put into mould.
2. After that, the mould containing chocolate allowed to store in the freezer.

Observation:

Second trail is failed because chocolate does not get shape due to less quantity of cocoa butter.

Figure 4: Arjuna bark Chocolate

Trail 3:

Formulation Table:

Table 4: Formulation Table

Sr No	Ingredients	Quantity (50 gm)
1	Cocoa butter	20 gm
2	Cocoa powder	12 gm
3	Arjuna bark powder	5 gm
4	Honey	0.5 gm
5	Vanilla	0.5 gm
6	Milk powder	3 gm
7	Sugar	9 gm

Method of preparation:

1) Preparation of Arjuna Bark Extract:

Method: Ultrasonic Assisted Extraction (UAE):

1. Add 10 grams of Arjuna bark powder to a clean glass beaker or flask.
2. Add 50 mL of solvent (e.g., 70% ethanol) to the beaker containing the powdered bark. The solvent should completely cover the powder.
3. Place the beaker containing the Arjuna bark powder and solvent into the ultrasonic bath. Set the ultrasonic bath at a frequency of 20-40 kHz. The temperature should be maintained at 30-50°C for optimal extraction.
4. Sonicate the mixture for 30 to 60 minutes. The exact time can vary based on the desired extraction efficiency, but typically, 30 minutes is enough for significant extraction.

Figure 5: Arjuna bark powder

Figure 6: Digital ultrasonic cleaner

Figure 7: Filtration

Figure 8: Arjuna Bark Extract

2) Melting Cocoa Butter:

1. Add cocoa butter (20 gm) into the beaker, Stir gently until cocoa butter melts.

3) Adding Other Ingredients:

1. After melting cocoa butter in different beaker, melted butter was added to weighed cocoa powder and sugar
2. Honey was added.
3. Then arjuna bark extract was finally measured and added.
4. After that vanilla was added as flaouring agent.

Figure 9: Wet mass of Arjuna bark chocolate

4) Moulding and Cooling:

1. Then mixture is put into mould.
2. After that, the mould containing chocolate allowed to store in the freezer.

Figure 10: Chocolate Mould

Figure 11: Arjuna bark Chocolate

Due to better result of this trial we decided to finalize this formula for preparation of chocolate

EVALUATION TESTS FOR CHOCOLATE:

1) Organoleptic Tests:

Table 5: Organoleptic Tests

Parameters	Observation
Texture	Smooth
Odour	Pleasant
Taste	Sweet
Tongue sensation	Silky and Grasping
Apperance	Lustrous

2) PH test: The pH of the Chocolate was found to be 6.5.

3) Phytocemical Tests:

1. Test for Carbohydrates: (Molisch's Test)

- Add 2-3 drops of Molisch's reagent (a-naphthol solution) to the extract of Arjuna bark chocolate.
- Add 2-3 mL of concentrated sulfuric acid carefully along the side of the test tube to for layer.

Observation:

A purple or violet ring at the interface of the two liquids indicates the presence of carbohydrates.

Inference: Passed

Figure 12: Molisch's test

2. Test for Reducing Sugars:(Benedict's Test)

- Add 1 mL of Benedict's reagent to 1 mL of the extract.
- Heat the mixture in a boiling water bath for about 5 minutes.

Observation:

Blue: No reducing sugar present.

Green/Yellow/Orange/Red: Increasing concentrations reducing sugars present.

Inference: Passed

Figure 13: Benedict's test

3. Test for Proteins: (Biuret Test)

- Take a small amount of the extract (or chocolate) in a test tube.
- Add a few drops of sodium hydroxide (NaOH) solution.
- Add a few drops of copper sulfate ($CuSO_4$) solution to the test tube.
- Mix the contents gently.

Observation:

A violet or purple color will form if proteins are present.

Inference: Passed

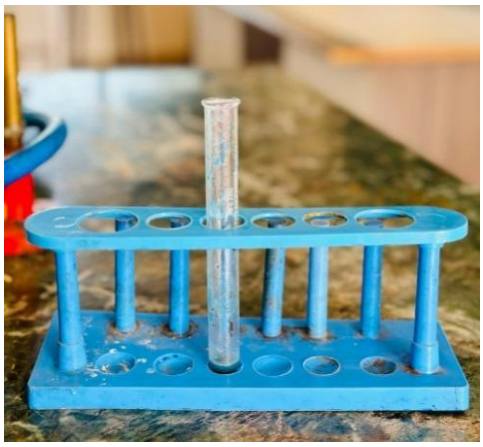

Figure 14: Biuret test

4. Test for Alkaloids: (Dragendorff's Test)

- Take a small amount of the extract (or chocolate) in a test tube.
- Add Dragendorff's reagent (a solution of potassium bismuth iodide).
- Mix the solution gently.

Observation:

An orange or red precipitate will form if alkaloids are present.

Inference: Passed

Figure 15: Dragendorff's test

5. Test for Amino Acids: (Ninhydrin Test)

- Take a small amount of the extract (or chocolate) in a test tube.
- Add a few drops of ninhydrin solution to the test test tube. Heat the test tube gently in a boiling water bath for a few minutes.

Observation:

A purple or blue color indicates the presence of amino acids or proteins.

Inference: Passed

Figure 16: Ninhydrin test

RESULT AND DISCUSSION:

The research successfully developed Arjuna bark chocolate as a novel functional food product that blends the therapeutic properties of Arjuna bark with the enjoyable taste of chocolate. The formulations exhibited a balance between health benefits and sensory appeal, making it a promising candidate for individuals seeking to improve their heart health naturally. The product's antioxidant content and potential cardiovascular benefits align with the increasing demand for functional foods that provide both taste and health benefits. Further studies, including clinical trials, are recommended to fully understand the therapeutic effects of Arjuna bark chocolate and its long-term health benefits. The findings suggest that Arjuna bark chocolate could serve as an innovative health snack, combining enjoyment with functional benefits for heart health.

CONCLUSION

Arjuna bark chocolate represents an innovative approach to incorporating traditional herbal medicine into modern functional foods. Through careful formulation and evaluation, this product could become a valuable addition to heart disease prevention and management. The future scope includes expanding the product range, improving bioavailability, personalizing formulations, and integrating these products into comprehensive heart-healthy diets. With further research and development, this could potentially revolutionize how natural remedies are integrated into modern health strategies.

Future scope

This concept could be expanded to other forms of functional food like Arjuna bark-infused energy bars, smoothies, or even dietary supplements. The versatility of chocolate as a carrier for active compounds makes it an excellent medium for creating heart-healthy products. Future research can focus on improving the bioavailability of Arjuna bark's active compounds. Techniques like nanoencapsulation or the use of bio-enhancers may help enhance the absorption of these compounds, making the product even more effective.

Acknowledgement: None

Conflicts of Interests: There are no conflicts of interest.

Funding: Nil

Authors Contributions: All the authors have contributed equally.

Source of Support: Nil

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Ethics approval: Not Applicable.

REFERENCES

1. Khan ZK, Lambhate VH, Raut RR, Jagadal VA, Jawal DT, Formulation and evaluation of herbal chocolate from Arjuna Bark treatment of heart disease condition, Indian Journal of Pharmacy and Pharmacology 2023; 10(4):272-280. https://doi.org/10.18231/j.ijpp.2023.047

2. Pawar PD, Bakliwal AA, Talele SG, Jadhav A, Formulation and evaluation of herbal chocolate as nervine tonic, Journal of Pharmaceutical Sciences and Research, 2019; 11(5):1808-1813.

3. Tiwari V, Shamim A, A Practical Book Of Pharmacognosy and Phytochemistry, 1st edition, Nirali Publication, 2018. P. 7-8.

4. Kapoor D, Vijayvergiya R, Dhawan V. Terminalia arjuna in coronary artery disease: ethnopharmacology, pre-clinical, clinical & safety evaluation, Journal of ethnopharmacology, 2014; 155(2):1029-1045. https://doi.org/10.1016/j.jep.2014.06.056 PMid:25014508

5. Sharma PC, Yelne MB, Dennis TJ, Database on medicinal plants used in Ayurveda, New Delhi: CCRAS; 2005.

6. Chopra RN, Chopra IC, Handa KL, Kapur LD, editors. Terminalia arjuna W&A (Combretaceae) Indigenous drugs of India, 2nd edition Calcutta, Academic Publishers. 1958:421-424.

7. A.K. Nadkarni Indian Materia Medica (1st ed.), Popular Prakashan, Mumbai, India, 1976. P. 40-47.

8. Dwivedi S, Chansouria JN, Somani PN, Udupa KN, Effect of Terminalia arjuna on ischaemic heart disease, Alternative medicine, 1989; 3(2):115-122. https://doi.org/10.4103/2225-4110.139103 PMid:25379463 PMCid:PMC4220499

9. Jain V, Poonia A, Agarwal RP, Panwar RB, Kochar DK, Misra SN, Effect of Terminalia arjuna in patients of angina pectoris, Ind Med Gaz, 1992; 36:56-90. https://doi.org/10.4103/2225-4110.139103 PMid:25379463 PMCid:PMC4220499

10. Verma SK, Bordia A. Effect of Terminalia arjuna bark (arjun chhal) in patients of congestive heart failure and hypertension, J Res Educ Indian Med, 1988; 7(31):190-191.

11. Bharani A, Ganguly A, Bhargava KD. Salutary effect of Terminalia arjuna in patients with severe refractory heart failure. International Journal of Cardiology. 1995; 49(3):191-199. https://doi.org/10.1016/0167-5273(95)02320-V PMid:7649665

12. Yegnanarayan R, Sangle SA, Sirsikar SS, Mitra DK, Regression of cardiac hypertrophy in hypertensive patients Comparison of Abana with propranolol Phytotherapy Research: An International Journal Devoted to Medical and Scientific Research on Plants and Plant Products, 1997; 11(3):257-267. https://doi.org/10.1002/(SICI)1099-1573(199705)11:3<257::AID-PTR79>3.0.CO;2-U

13. Sandhu JS, Shah B, Shenoy S, Chauhan S, Lavekar GS, Padhi MM, Effects of Withania somnifera (Ashwagandha) and Terminalia arjuna (Arjuna) on physical performance and cardiorespiratory endurance in healthy young adults, International journal of Ayurveda research, 2010; 1(3):144. https://doi.org/10.4103/0974-7788.72485 PMid:21170205 PMCid:PMC2996571

14. Bhawani G, Kumar A, Murthy KS, Kumari N, Swami CG, A retrospective study of effect of Terminalia arjuna and evidence based standard therapy on echocardiographic parameters in patients of dilated cardiomyopathy, Journal of Pharmacy Research, 2013; 6(5):493-8. https://doi.org/10.1016/j.jopr.2013.05.006

15. Hegde, A, et al, "Antioxidant Properties of Terminalia arjuna: A Clinical Study." Phytotherapy Research, 2006; 20(1), 8-11.